# Target Generation Facility (TGF)
# ACB-860 Simulation Group

# Project Summary

# Fiscal Year 2010


## Dan Warburton


**October 15, 2010**

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# TGF Project Summary FY 2010

## Executive Summary

The Target Generation Facility (TGF) completed another successful simulation year. All simulations were provided on-time and met or exceeded customer expectations. In addition to completing these simulations many enhancements were added to the Target Generation Facility's aircraft dynamics engine, simulation pilot workstation and hardware infrastructure.

In Fiscal year 2010 we supported the ERAM Test Design Group (ATO-E/AJE-12A1) in the Operational Evaluations of System Issues Group (SIG) fixes, Problem Reports (PRs), and Automation Issue Management System (AIMS) tickets for ERAM Release 2. We also supported several Demos to ERAM Keysite personnel on critical ERAM fixes. Support was provided for the full 52 weeks of the year with an average of 4 simulations per week.

The TGF also provided vital technical support in the successful opening of the NIEC laboratories, providing two of the fundamental simulation technologies (TGF/VAIE). As well as simulation support for the initial UAS and SNT program simulations conducted in the laboratory.

## Section 1 – Simulation Projects Supported

This section summarizes the simulation efforts supported by the Target Generation Facility during the fiscal year.

### 1.1 ERAM Operational Testing – Regression Testing – DR Closeout activities

Simulation Dates: October 2009 – September 2010

Program Office: ERAM ATO-E/AJE-12A1

Contacts:

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Simulation Summary

In Fiscal year 2010 we supported the ERAM Test Design Group (ATO-E/AJE-12A1) in the Operational Evaluations of System Issues Group (SIG) fixes, Problem Reports (PRs), and Automation Issue Management System (AIMS) tickets for ERAM Release 2. We also supported several Demos to ERAM Keysite personnel on critical ERAM fixes. We upgraded all scenarios to use IP radars at the IIF lab which provides the benefit of all the Air Traffic Control Center radars being available for use.

We continue to accommodate an intensive ERAM system release schedule and completed over 47 uplevels of the SGET scenario data. In addition this year we've been tasked with supporting additional simultaneous lab runs in the I2F bringing our total simulation time / lab support to over 1668 hours. With simulation laboratory sessions 4 or five times a week and 2 to 3 sims per laboratory sessions **we estimate at least 416 simulations provided**. (52 weeks * 4 sessions * 2 sims = 416 simulation performed)

## 1.2 Tower Data Communications (TDCS2)

Simulation Dates: October-December 2009

Program Office: ATO-P Research and Technology Development Office AJP-6

Contacts:

| NAME | ORG | EMAIL | PHONE | ROLE |
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Simulation Summary

Conduct an experiment to assess the impact of Tower Data Comm segment 2 concepts on controller performance (workload, communications, awareness, etc.) in the tower

The Genera Tower based on Boston-Logan Intl Airport is being modeled for this simulation.

This simulation was conducted in the RDHFL with support from the TGF/VAIE technologies.

### 1.3 FTWS2

Simulation Dates: October 2009 – February 2010

Program Office: AT System Concept Development Group, AJP-66

Contacts:

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|---|---|---|---|---|
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Simulation Summary

Determine the effects on controller workload and performance of different levels of DataComm equipage and user interface designs.

This simulation used Genera airspace developed for the FTWS-1 simulations.

This simulation was conducted in the RDHFL with support from the TGF technologies.

## 1.4 UAS Cherry Point

Simulation Dates: October 2009 – February 2010

Program Office: AFS Unmanned Aircraft Program Office, AFS-407
ATO Unmanned Aircraft Systems Office, AJR-36

Contacts:

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Simulation Summary

To support the UAS integration into the NAS. It will explore an actual proposed near-term UAS operation involving the Shadow 200 UAS. It will also explore a Ground Based Sense and Avoid (GBSAA) concept proposed for UAS.

Class D airspace at Marine Corps Air Station (MCAS) Cherry Point, North Carolina. Operation will include Shadow UAS transitioning to/from restricted airspace (R5306A, C and D). All simulated scenarios will be contained in terminal airspace (automation system is STARS). The ZDC center adaptation data was used to build the airspace for this simulation.

This simulation was conducted in the NIEC with support from the TGF technologies.

**1.5 Staffed NextGen Tower DFW**

Simulation Dates: February – May 2010

Program Office: AT System Concept Development

Contacts:

| NAME | ORG | EMAIL | PHONE | ROLE |
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| Best, Christopher | TGF | cbest@tgf.tc.faa.gov | 609-485-7372 | TGF Visual Simulation Development |
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| Lykens, Jonathan | TGF | lykensj@tgf.tc.faa.gov | 609-485-4245 | TGF Software Development (ASTRIX) |
| Nickelson, Monicarol | FAA AJP-66 | monicarol.nickelson@faa.gov | 609-485-433? | Principle Investigator |
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| | | | | |
|---|---|---|---|---|
| | | | | FDIO Development |

Simulation Summary

The key goal of this Human In The Loop simulation is the identification of visual-perceptual elements used in controlling air traffic and the best strategies and tools to respond to the lack of them in both nominal and non-nominal situations. The information obtained from this study will lead to the generation of information display requirements.

SNT 1.0 evaluated Staffed NextGen Tower concepts via simulation of the center tower at DFW airport in varying weather conditions with varying traffic levels. The traffic consisted primarily of northeastern arrivals and southeastern departures via the three parallel east side runways at DFW, with some GA departures via the offset runway. Most of the departures were required to cross active runways, while the arrivals were able to use the southern perimeter taxiway to reach the terminal without crossing runways.

TGF received additional simpilot command logic to handle the more complicated taxi requirements of the DFW airport. It also gained a direct, two-way communication channel with VAIE that allows it limited control over the visual simulator. For SNT this was primarily used for triggering the 'runway incursion' effect. TGF also achieved integration with MIT Lincoln Labs' Tower Information Display System (TIDS), providing real-time flight plan information in their custom XML format and target information in the native ASDE-X format. This, combined with TGF's existing DIS capabilities and Desiree integration, allowed the experiment to evaluate SNT conditions with both a proposed NextGen controller display and a current generation ASDE-X display (simulated via Desiree).

## 1.6 NIEC Next Gen Laboratory Development

Simulation Dates: March – May 2010

Program Office: Laboratory Services Group, AJP-78

Contacts:

| NAME | ORG | EMAIL | PHONE | ROLE |
|---|---|---|---|---|
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| | | | | |
| | | | | |

Simulation Summary

The NIEC is the FAA's research platform to explore, integrate, and evaluate NextGen concepts through simulation activities resulting in concept maturation and requirements definition. The NIEC Display Area (NDA) complements the unique NAS facilities and aviation based equipment located at the WJHTC.

The NIEC leverages existing NAS operational systems and high fidelity, real-time simulation capabilities to create an integrated, flexible and reconfigurable environment that can be tailored for NextGen research as well as test and evaluation. The NDA can provide a futuristic NextGen gate to gate visualization environment with advanced data collection capabilities to support integration and evaluation of new technologies and concepts. The ability to provide a combined environment of legacy systems with future technologies and capabilities also enable the NIEC to support the transition to NextGen.

Characteristics of the NIEC include:

- A collocated NIEC display area to support Human-in-the-Loop simulations
- A real-time, rapid prototyping and simulation environment that simulates the NAS while integrating NextGen enabling components
- Technical Center and external laboratory integration capabilities
- Voice communications capabilities
- Audio, video, and data recording capabilities
- The flexibility to support multiple concurrent studies
- Available 24 hours per day 7 days a week

- Certified ISO 9001:2008 laboratory

This demonstration was part of the opening day of the NIEC laboratory. The Target Generation Facility and the Virtual Airport Immersion System (description below) were configured to simulate the Dallas Fort Worth ATC environment.

Virtual Airport Immersion System (VAIE)
The Virtual Airport Immersion Environment (VAIE) contains a 180 degree out of the window view. The VAIE is a highly extensible 3D rendering solution for the Target Generation Facility's high-fidelity air-traffic simulator. The VAIE uses TGF's internally developed DANSIG image generator software which was built from the ground up to be modular and easily customizable. DANSIG uses advanced rendering techniques to efficiently handle many scene lights - often 5 per aircraft - that produce highly realistic lighting effects that interact with the terrain and other aircraft in the scene.
OpenSceneGraph based rendering of aircraft and airports.
Aircraft and Ground vehicle motion projected to a WGS84 coordinate system using TGF's internal algorithms.
Real-time ephemeris calculations for sky color, lighting conditions, starfield, etc. using SilverLining.
Real-time shadow rendering based on calculated sun/moon position.
Real-time aircraft lighting (navigation, taxi, landing, etc.) that affects the environment.
Real-time weather effects (snow/rain, fog, clouds)
Particle-system based special effects (fire, smoke, etc.

**1.7 UAS INI**

Simulation Dates: April – July 2010

Program Office: AFS Unmanned Aircraft Program Office, AFS-407
ATO Unmanned Aircraft Systems Office, AJR-36

Contacts:

| NAME | ORG | EMAIL | PHONE | ROLE |
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Simulation Summary:

The purpose of this simulation was to conduct concept validation activities to support Unmanned Aircraft System (UAS) integration in the NAS/NextGen environment. The Jacksonville (ZJX) ARTCC and Jacksonville (JAX) TRACON were configured in the TGF for simulation.

This simulation was conducted in the NIEC with support from the TGF technologies.

**1.8 Georgia Tech**

Simulation Date: May – Aug 2010

Program Office: FAA-AEE (Office of Environment & Energy)

Contacts:

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Simulation Summary

This project is composed of two main efforts,; The first half involves the development of an optimization algorithm for en-route traffic to reduce fuel burn and emissions, and a decision support system, or a decision support tool (DST), supported by information from this algorithm.; the second half involves the testing of the algorithm and the DST by conducting a series of real-time human-in-the-loop simulation studies.

The en-route environment of the Memphis Center (ZME) and surrounding centers, Fort-Worth (ZFW), Houston (ZHU), Atlanta (ZTL), Kansas City (ZKC), Indianapolis (ZID), Jacksonville (ZJX) was simulated..

The project required six days of traffic to create the flight samples, specifically, 2 clear weather days, and 2 convective weather days inside ZME and / or 2 outside (in adjacent centers).

The software optimization algorithm and decision support tool (DST) were developed by the customer/Georgia Tech. Actual traffic flow data (e.g. Aircraft details, position, altitude levels, velocity) were supplied as input to the optimization algorithm, and outputs of the optimization algorithm were channeled to the DST. The algorithm and DST were interfaced and tested with the TGF.
This simulation was conducted in the IIF with support from the TGF technologies.

## Section 2 – Technical Summary

This section summarizes the technical achievements and "state of the art" of the TGF during the fiscal year.

### 2.1 TGF Simulation Engine (ECO)

Every project this fiscal year was conducted solely with the JAVA-Based simulator. Enhancements to the ground simulator to allow the simulation of DFW East runways were added to the ground simulation. We added the capability to simulate ramp operations in anticipation of future simulations. We developed an ASTRIX ASDE-X DDU simulator to support the LL TIDS display. We added SWIM SOA technologies to add Flight Plan publishing capabilities to support the LL Flight Data Manager (FDM). AnADS-B simulator was developed in conjunction with the Surveillance Team AJP-653

### 2.2 Virtual Airport Immersion Environment (VAIE)

The VAIE is a highly extensible 3D rendering solution for the Target Generation Facility's high-fidelity air-traffic simulator. The VAIE uses TGF's internally developed DANSIG image generator software which was built from the ground up to be modular and easily customizable. DANSIG uses advanced rendering techniques to efficiently handle many scene lights - often 5 per aircraft - that produce highly realistic lighting effects that interact with the terrain and other aircraft in the scene.OpenSceneGraph based rendering of aircraft and airports. Aircraft and Ground vehicle motion projected to a WGS84 coordinate system using TGF's internal algorithms. Real-time ephemeris calculations for sky color, lighting conditions, starfield, etc. are performed using SilverLining. Real-time shadow rendering is based on calculated sun/moon position. Real-time aircraft lights (navigation, taxi, landing, etc.) that follows the light discipline based on aircraft movement and affects the environment. The VAIE renders Real-time weather effects (snow/rain, fog, clouds) and has a Particle-system based special effects for fire, smoke, landing tire smoke etc.

In FY10 DANSIG an image generator (IG) was developed and replaced the older MPV IG. It communicates using the industry standard Common Interface to Image Generators (CIGI) and renders using OpenSceneGraph, an open source Scene Graph. SilverLining, a COTS product for generation real-time environmental effects was integrated into DANSIG. VAIE now generates simulated camera views (mpeg2 stream) and responds to camera control commands. .

### 2.3 Sim-Pilot Laboratory Enhancements

The remaining wrightline consoles for the Sim-Pilot laboratory were purchased and installed. We purchased and installed enough hardware to populate the full 33 pilot workstations. Added 26' monitors to half the laboratory (FY11 will complete). We installed Cent OS 5.4 on all pilot laboratory workstations. Dimmable lighting was installed in the laboratory.

### 2.4 Networking Enhancements

The TGF network infrastructure comprises ~30 devices. These devices range from the smallest access layer Cisco 2960G switch to the core Cisco 6506 router (installed-early 2000's). The devices provide an infrastructure to transport all TGF simulation network traffic. The type of network traffic ranges from point-to-point to multicast to subnet broadcasts. These different types of traffic may originate and terminate locally with the TGF, or inter-lab, e.g., NIEC displays targets driven by the TGF simulator(s).

TGF simulations have increased the network traffic 10 fold with the introduction of VAIE. TGF replaced many of the older distribution switches the FY10 in response to packet drops and, in consultation with cisco and LABNET engineers, determined an upgrade plan for FY11.

### 2.5 Workstation Environment

The workstation environment moved to 64 bit OS (Fedora 13/CentOS 5.4) this FY. We added SSD's for local storage and are running Intel I7's with 6 gb of storage.

We are using SVN for source code management and GIT for data management. We have an active wiki http://trac.tgf.tc.faa.gov.

### 2.6 TGF Back End Systems

TGF installed a new NAS system based on Sun Microsystems technology with 14TB of data storage and redundant network access. An updated backup system is planned for FY11.

### 2.7 TGF Display Laboratory

TGF completed the installation of an updated projection and video switching system. The new projector is capable of 4 1080p video streams and is integrated with the RGB video switch to allow source selection and window position. Screen size is 8 x 16 (feet☺).

# Acronyms and Abbreviations

| | |
|---|---|
| ADAR | ARTS Data Acquisition & Router |
| AGW | ARTS Gate Way |
| ARTS | Automated Radar Terminal System |
| ATCT | Air Traffic Control Tower |
| CAS | Controller Awareness Study |
| CTAS | Center TRACON Automation System |
| CHI | Computer Human Interface |
| CPDLS | Controller Pilot Data Link Communications |
| DFS | Deutsche Flugsicherung (German Simulation) |
| DIS | Distributed Interactive Simulation |
| DRVSM | Domestic Reduced Vertical Separation Minimum |
| DSR | Display System Replacement |
| EDC | Early Display Configuration |
| ETVS | Enhanced Terminal Voice Switch |
| FAST | Final Approach Spacing Tool |
| FFP | Free Flight Phase |
| FS1, 2/2+ | Full Service 1, 2/2+ |
| GAO | Government Accounting Office |
| GOERS | GPS Outage En route Simulation |
| GPS | Global Positioning System |
| HAD | High Altitude Demonstration |
| HAT | High Altitude Test |
| HFL | Human Factors Laboratory |
| HLA | High Level Architecture |
| IIF | Integration and Interoperability Facility |
| LAAEP | LA Arrival Enhancement Project |
| McTMA | Multi-Center Traffic Management Advisor |
| NAS | National Airspace System |
| NATCA | National Air Traffic Controllers Association |

| | |
|---|---|
| PARR | Problem Analysis Resolution and Ranking |
| PAS | Pseudo Aircraft System |
| PDU | Protocol Data Units |
| PTR | Program Trouble Reports |
| RDHFL | Research Development and Human Factors Laboratory |
| RNAV | Area Navigation |
| RVSM | Reduced Vertical Separation Minimum |
| STARS | Stand Alone Terminal ARTS Replacement System |
| TATCA | Terminal Air Traffic Control Automation |
| TFM | Traffic Flow Management |
| TGF | Target Generation Facility |
| TMA | Traffic Management Advisor |
| TRACON | Terminal Radar Approach Control |
| URET | User Request Evaluation Tool |
| WJHTC | William J. Hughes Technical Center |
| XPVD | X-windows Planned View Display |